AVnu Alliance™ White Paper

AVB for Professional A/V Use

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Author

Rick Kreifeldt

Contributors

Amy Chang, Allen J. Huotari, Yong Kim, Kimberly Lewis, Kevin B. Stanton

Executive Summary

Over the last decade, the high end of the Professional Audio/Video market has embraced Ethernet more and more as the predominant means for distribution in large-scale systems such as sporting facilities, convention centers, and concert halls. Due to the proprietary solutions employed, broader market applications have not been served. The recent work of the IEEE 802.1 Audio/Video Bridging Task Group offers a compelling draft standards-based solution that will broaden the professional use of networked A/V into smaller installations, studios, and additional live sound applications. This whitepaper outlines the technology and benefits for the Professional A/V market.

About AVnu Alliance

The AVnu Alliance is an industry forum dedicated to the advancement of professional-quality audio video transport by promoting the adoption of the IEEE 802.1 Audio Video Bridging (AVB), and the related IEEE 1722 and IEEE 1733, standards over various networking link-layers. The organization will create compliance test procedures and processes that help ensure AVB interoperability of networked A/V devices, helping to provide high quality streaming A/V experience. The Alliance will promote awareness of the benefits of AVB technologies and intends to collaborate with other organizations and entities to make use of this work in their respective efforts to provide a better end-user A/V experience.

The Alliance is focused on applications of these technologies in the Automotive, Professional, and Consumer Electronics markets.

Introduction

Over the course of the last decade, Ethernet and Wi-Fi have become the most dominant of all networking technologies. Many people with a computer have at one time or another plugged into an Ethernet network via the RJ45 jack. As time has progressed, both of these technologies have continuously pushed the boundaries of speed – with the current state-of-the-art Ethernet moving to 100Gbps. Given the enormous cost savings in cabling and other infrastructure over analog cable, it seems natural that networked audio/video would be very widespread in the professional world, but it is not. Only the largest facilities routinely employ networked systems. Professional A/V applications have been hampered by two main problems: high per-node cost and daunting technical expertise required to deploy a networked A/V system. These issues could not be tackled by the proprietary solutions that emerged over the last decade. Only the extreme economies of scale realized by standards-based silicon could change the equation in the professional market. The IEEE AVB task group is developing a series of enhancements that provide the means for the highly-reliable delivery of low-latency, synchronized audio and video. This technology is expected to provide the capabilities and functionality to construct affordable, high-performance professional media networks.

Benefits

Synchronization

All AVB devices are synchronized to a common time-base reference via the IEEE 802.1 AS Precision Time Protocol (PTP). The 802.1 AS protocol defines clock master selection algorithms, link delay and networking queuing measurement and compensation, and clock rate matching and adjustment mechanisms. To make use of 802.1AS, streams are expected to include a presentation time. All devices in the network can then align their playback using by comparing the presentation time information in the stream packets to the 802.1 AS common time-base. One advantage of this approach is that the with 802.1AS and presentation time-encapsulated streams, and AVB network inherently supports multiple simultaneous sample rates and sample clock sources which allow, for example, video and audio streams to be synchronized even though they travel on different paths with different sample rates. A second advantage of utilizing presentation time is that if there are two devices outputting the same stream, they are precisely locked in their playback even though they may be a different network distance away from the source.

Reliability with no infrastructure configuration

First and foremost, a professional A/V network needs reliable transmission with no audio defects (pops or clicks), video dropouts, or other artifacts. The niche solutions currently employed in large professional systems have required engineered networks with multiple VLANs and careful hand-tuning of topology and parameters. The IEEE 802.1Qat Stream Reservation Protocol (SRP) provides mechanisms for reserving stream bandwidth that allows endpoint applications to configure the routes, eliminating the need for this type of infrastructure network engineering. SRP checks end-to-end bandwidth availability before an A/V stream starts. If bandwidth is available, it is "locked down" along the entire path until explicitly released. SRP works hand-in-hand with the IEEE 802.1Qav Queuing and Forwarding Protocol (Qav). Qav schedules time-sensitive A/V streaming data, ensuring timeliness through the network. Regular non-steaming traffic is treated in such a way that it cannot interfere with reserved AVB traffic. Utilizing the AVB protocols, intelligent devices communicate with the network to provide reliable A/V streaming without the need for the installer to perform extensive hand tuning of the network.

Low-latency

SRP and the Qav protocols together ensure end-to-end timely delivery of all reserved media streams. Without these protocols, there is no way to know how much intervening non-media traffic or how many media packets the switches may queue up.

Designers of previous proprietary systems built in large amounts of buffering at the end nodes because of the uncertainty of when you will receive a media packet. With AVB on a wired Ethernet network, the worse case travel time is known throughout the entire network. As a result, only a small amount of buffering is required and very low latencies – 2 milliseconds over seven switch hops in a 100 Mbps Ethernet network – can be achieved, and even better at gigabit speeds.

Networked Live Sound

Let's face it – analog wiring is simple and easy – and heavy. Networked control of amplifiers or powered loudspeakers is commonplace and there is a natural desire to use that same Ethernet cabling for signal transport. Thanks to the emerging standards of the AVB group, we can easily combine audio streaming plus control – without requiring the user to become an IT expert. The highly-reliable delivery offered by SRP makes AVB as simple as analog – route a signal from one device to another and you know it will get there – every time – with no glitches.

With modern gigabit Ethernet solutions, the latency of an AVB network can be virtually imperceptible. At roughly 25 microseconds per switch hop, the minimum possible latency between two digital products connected with AVB will be much lower than the latency of those same two products connected via analog with the resulting extra D/A and A/D conversion.

AVB in the Studio

Ethernet in the recording studio is a natural, whether in a small home-recording studio or a large broadcast facility. In the future if computers with AVB capable ports are available, then the home recording enthusiast will have an easy and affordable high-bandwidth recording interface. On the high-end of the market, large broadcasting facilities that need to route and switch uncompressed HD video can find their infrastructure greatly reduced when an AVB network does the routing for them instead of an expensive purpose-built central HD-video router. With the addition of AVB capabilities to 10G and 100G Ethernet, the largest broadcast facility can enjoy networked HD video distribution and matrixing utilizing modern IT networks.

AVB Installed in your nightclub, church, or theme park

Contractors and consultants that currently are either working with proprietary solutions or seldom deploy networked audio/video because of the cost and complexity will find AVB meets their needs. It has all the performance needed for the most demanding system, with simple-to-no network management. AVB can be added to Professional Audio/Video products at all different price-points and performance levels; moving networked systems down from large-scale installations to the nightclub or small church level.

A System That Grows With You

Because AVB is being developed by the IEEE standards community it will benefit from ever-increasing speeds and other options and features. For example, HD video can easily be passed uncompressed over a 10 Gigabit Ethernet link, which today can be affordably delivered over copper cable or optical at long distances. Upper-layer features like security and network management can be used as needed without engineering a custom solution.

Multiple Suppliers

Many small microcontrollers and DSPs are Ethernet capable today. With only a small silicon change, these chips can easily support AVB. The costs of designing these devices can be amortized over many different markets, not just a niche part for the Professional market. In the past, companies with proprietary solutions have had difficulty funding the development of their next-generation chip, leaving the Pro Audio industry stalled at a given capability. Because of the wide applicability of the technology, the Professional A/V market will reap the benefits of solutions aimed at the mass-market. Several silicon companies have already announced plans to support AVB – and more can be expected soon.

Brief Technology Overview

For a more thorough treatment of the AVB technologies, see [whitepaper on AVnu website].

Four IEEE 802.1 AVB draft standards form the foundation of the technology that will be promoted by the AVnu Alliance and—like other 802.1 standards—describe interworking/bridging between various network link technologies. It's important to note, however, that this is not intended to imply that the services provided by the AVB standards over every kind of network link are identical, since each link technology has different characteristics.

Below are the four foundational standards. As of July 2009 all were in draft form with expected completion in 2010 and 2011:

- IEEE 802.1AS (PTP): "Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks." This auto-selects a device to be the master clock, which then distributes time throughout the bridged LAN / IP subnet to all other nodes. The 802.1AS clock is not used as a media clock. Rather, the 802.1AS time is used as a shared clock reference between nodes which is used to port a media clock from talker to listener. Such a reference removes the need to fix the latency of packet delivery, or compute long running averages in order to estimate the actual media rate of the transmitter in the presence of substantial network jitter. IEEE 802.1AS is based on the ratified IEEE 1588-2008 standard.
- IEEE 802.1Qat (SRP): "Virtual Bridged Local Area Networks - Amendment 9: Stream Reservation Protocol (SRP) ." This allows a stream reservation to be established between a talker and listener in a bridged LAN / IP subnet.
- IEEE 802.1Qav (Qav): "Virtual Bridged Local Area Networks - Amendment 11: Forwarding and Queuing for Time-Sensitive Streams." This describes a token-bucket method for shaping network traffic such that the latency and bandwidth of reserved streams can be controlled.
- IEEE 802.1BA: "Audio/Video Bridging (AVB) Systems"

There are also two draft standards that rely on IEEE 802.1 AVB to provide professional quality Audio/Video.

- IEEE 1722: "Layer 2 Transport Protocol for Time-Sensitive Streams." Allows easier porting of applications currently using IEEE 1394 (FireWire®) to AVB.
- IEEE 1733 - extends RTCP for RTP streaming over AVB-supported networks.
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Conclusion

We are at the leading edge of a new wave of professional networked audio/video systems. Intelligent A/V products that communicate with an intelligent network infrastructure means an end to time-consuming hand-engineered networks. The AVB protocols provide the reliability and capabilities for the most demanding professional applications. The broad industry appeal and open standards nature of the work of the IEEE AVB group promise an economy of scale that will reduce the cost of adding streaming capabilities to professional A/V devices. Please contact the AVnu Alliance at www.AVnu.org to find out more about AVB and its applications into Professional A/V.